

**STATEMENT OF WORK  
ASSOCIATED WITH  
IMPLEMENTING ARRANGEMENT NUMBER 17  
TECHNICAL ENHANCEMENTS  
FOR THE  
ADVANCED OPERATIONAL AVIATION WEATHER SYSTEM  
SUBJECT TO THE  
AGREEMENT  
BETWEEN THE  
TAIPEI ECONOMIC AND CULTURAL REPRESENTATIVE OFFICE IN THE  
UNITED STATES  
AND THE  
AMERICAN INSTITUTE IN TAIWAN  
FOR  
TECHNICAL COOPERATION  
ASSOCIATED WITH  
ESTABLISHMENT OF ADVANCED OPERATIONAL AVIATION WEATHER  
SYSTEMS**

## **1.0 Background and Objectives**

The Agreement between the Taipei Economic and Cultural Representative Office in the United States (TECRO) and the American Institute in Taiwan (AIT) provides for technical cooperation between the Civil Aeronautics Administration (CAA), as TECRO's designated representative, and the University Corporation for Atmospheric Research (UCAR), as AIT's designated representative. CAA and UCAR will cooperate on the development and establishment of operational aviation weather systems.

The Advanced Operational Aviation Weather System (AOAWS) developed by TECRO's designated representative, CAA, requires up-to-date scientific and technical components in order to provide a high level of service to the aviation community on Taiwan. Most of this aviation weather science and technology has been developed by AIT's designated representative, UCAR, over the past two and a half decades and has been validated in operational environments both in the United States and in other countries.

The AOAWS consists of advanced meteorological sensor systems (at airports and within the Taiwan airspace), a communications infrastructure, a product generation component, a system server component that distributes products, and product displays that present the advanced aviation weather information to end users. The AOAWS system components have been integrated to form an operational, turn-key system that serves the aviation community.

TECRO and its designated representative, CAA, will be provided with the necessary technology required to develop and implement enhancements to the AOAWS system, from AIT's designated representative, UCAR, as defined herein.

## **2.0 Task Descriptions**

### **Task #1: Development of In-Flight Icing Diagnosis Product**

Toward the end of 2013, development of the AOAWS Current Icing Product (CIP) was completed and the CIP was implemented in the operational AOAWS. This product is designed to provide pilots (fixed-wing and rotor aircraft) with guidance information about current icing conditions, which supports their tactical decision making process. In 2014, in-flight icing case studies will be evaluated to ensure that the algorithm is performing as anticipated. If the case studies indicate that the CIP needs to be tuned to improve performance, AIT's designated representative, UCAR, will refine the algorithm accordingly.

Research and development activities associated with this task in 2014 include:

1. Evaluate selected icing case studies to ensure the algorithm is performing appropriately.
2. Recalibrate CIP if the case studies indicate that the algorithm could be improved.
3. Prepare a CIP case study evaluation report that will be included in the 3rd quarterly report.
4. Prepare a CIP benefits analysis and report findings in the Benefits Assessment Report.

### **Estimated Costs<sup>1</sup>**

#### Staff

Scientists (10 person-weeks)	US\$	58,000
Task #1 Total	US\$	58,000

### **Task #2: Development and Implementation of NCAR's Turbulence Detection Algorithm Product**

This product is designed to provide pilots with information about current turbulence conditions around clouds and thunderstorms. Toward the end of 2013, the primary development effort of the AOAWS NCAR Turbulence Detection Algorithm Product (NTDA) was completed and the NTDA was implemented for testing and evaluation in the operational AOAWS environment. This is a complex algorithm that relies heavily on the provision of high quality weather radar datasets. In 2014, turbulence case studies will be evaluated to evaluate radar data quality over a broad range of weather events and to ensure that the algorithm is performing as anticipated. If the case studies indicate that the NTDA code needs to be refined and tuned to improve performance, AIT's designated representative, UCAR, will refine the code and algorithms accordingly.

Research and development activities associated with this task in 2014 include:

1. Explore methods to reduce product latency, such as converting data ingest processing from a per-volume to PPI for all radars.
2. Evaluate radar data quality and scanning strategies for each of the contributing weather radars to ensure they are performing as anticipated.
3. Compare NTDA output from adjacent radars to assist in verification and tuning.

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<sup>1</sup> All UCAR manpower estimates are given as person-weeks. Costs reflect UCAR's full cost loading. In 2014, the anticipated rates are as follows: overhead rate is 58.8%; benefit rate is 53.8%; the UCAR fee is 3%; and computer service charge of US\$7.20 is applied per UCAR manpower hour.

4. Conduct a scientific evaluation of selected turbulence case studies to ensure the NTDA system is performing appropriately.
5. Modify and recalibrate NTDA if the case studies indicate that the algorithm could be improved.
6. Prepare an NTDA case study report that will be included in the 3rd quarterly report.
7. Prepare a NTDA benefits analysis and report findings in the Benefits Assessment Report.

## **Estimated Costs**

### Staff

Scientists (18 person-weeks)	US\$	104,400
Task #2 Total	US\$	104,400

## **Task #3: Enhancement of Airport Ceiling and Visibility Prediction Product**

In 2012, an improved version of the Airport Surface Weather Prediction Product, that included ceiling, visibility, wind, temperature, and relative humidity data, was implemented into the AOAWS. Subsequently, the Taipei Aeronautical Meteorological Center (TAMC) forecasters requested that a real-time verification capability be included for this product to help the forecasters monitor the performance of these forecasts. In this task, AIT's designated representative, UCAR, will develop and implement a verification capability for this product that will provide performance statistics for each of the predicted data elements.

Research and development activities associated with this task in 2014 include:

1. With feedback from the CAA, design the verification capability. The design process will:
  - a. Identify appropriate statistical performance metrics (e.g., root mean squared error, bias, absolute error, etc.)
  - b. Identify time periods for calculating performance statistics (e.g., weekly, monthly, seasonally, etc.)
  - c. Identify product display functionality
  - d. Identify data archiving methodology
2. Develop software to automatically generate graphics of performance for each predicted weather parameter (e.g., wind, temperature, relative humidity, ceiling and visibility).
3. Develop web pages for viewing the performance data.
4. Integrate and test the new product in the UCAR test environment.
5. Install the new product during the release installation on operational system.
6. Write documentation for new product.
7. Prepare a Ceiling and Visibility Prediction Product enhancement benefits analysis and report findings in the Benefits Assessment Report.

## Estimated Costs

### Staff

Software Engineering (8 person-weeks)	US\$	46,400
Scientists (1 person-weeks)	US\$	5,800
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Task #3 Total	US\$	52,200

## Task #4: Display System Enhancements

Enhancements or refinements to the Java-based Multi-dimensional Display System (JMDS), Web-based Multi-dimensional Display System (WMDS), Automated Weather Observing System (AWOS) Display, and/or System Monitor Display (SMD) will be developed and implemented based on user feedback and resources available during 2014.

In 2014, the display system enhancements task includes: (a) addition of a Meteorogram tool to the JMDS; (b) addition of a capability to create, save, and load view macros to the JMDS; (c) make usability-based refinements to the JMDS; (d) add ability to zoom using ICAO waypoints to the JMDS; (e) add ability to display MET and SPECIAL reports to the JMDS.

Additional minor enhancements to the JMDS and WMDS will be developed during 2014, if resources permit, based on user feedback and prioritization by TECRO's designated representative, CAA. Updates will be made to the AOAWS Meteorological Products, JMDS Users, AWOS Display manuals to reflect any system and product refinements and additions.

Development activities associated with this task in 2014 include:

1. Develop and implement a Meteorogram tool for the JMDS, based on the general design of a similar product that is part of the Aviation Digital Data System (ADDS) Flight Path Tool.
2. Develop and implement the capability to create, save, and load view macros for the JMDS. The view macro will allow a user to store the state, selected layers, products, and area of interest of a JMDS session. Access to the macro functionality will be through a pull down menu.
3. Develop and implement the following JMDS refinements based on a usability study:
  - a. Add ability to select multiple checkboxes in pull down menus (view, products, etc.)
  - b. Move 'reset' functionality to file menu
  - c. Change 'move to' (i.e. ICAO zoom) to an icon that brings up a 'move to' dialog
  - d. Clean up 'layer list' in upper left corner of plan view - improve show/hide functionality
  - e. Add waypoints data to ICAO zoom tool
  - f. Improve help/browser integration for help pages
4. Add TAMC-generated MET and SPECIAL REPORTS to the WMDS and JMDS. The reports will be displayed as text.
5. Support the operational versions of the JMDS, WMDS, SMD, and AWOS systems.

6. Respond to user feedback and, as appropriate, provide and develop enhancements to address issues raised by the users as resources permit.
7. Update AOAWS Meteorological Products, JMDS Users and AWOS Display manuals and convert them to PDF format, which is suitable for both printing and on-line browsing. Provide a link to the manuals from suitable AOAWS web pages.

## Estimated Costs

<u>Staff</u>	
Software Engineering (15 person-weeks)	US\$ 87,000
<u>Travel</u>	
1 trip @ 1-week	US\$ 12,000
Task #4 Total	US\$ 99,000

## Task #5: AOAWS Data System Upgrades, Testing, and Integration

This task focuses on the addition of new data types and processing to the AOAWS infrastructure that will be available at the time of the release installation. This task also includes testing and integration of the new software in the AOAWS test environment at AIT's designated representative, UCAR, before it is released into the operational AOAWS on Taiwan. In addition, UCAR will monitor and correct any problems that arise from system upgrades during the project period.

Over recent years, the use of AOAWS data products have expanded to other groups within the CAA as well as external users such as airlines, and it appears that this trend will continue. Many of the data dissemination methods and formats used in AOAWS are considered 'internal' and are used for inter-process communication and are not suitable for external users, hence alternate dissemination methods and formats need to be developed to provide a more robust interface to current and anticipated future external stakeholders and systems.

In order to allow the continued expansion of AOAWS data usage, an AOAWS External Data Services System (EDSS) will be developed which will be based on standard meteorological data delivery mechanisms and formats, such as the Local Data Manager (LDM), Thematic Realtime Environmental Distributed Data Services (THREDDS), and Network Common Data Form (netCDF). These meteorological data standards, which are widely used in the meteorological research and operational communities around the world, are well supported by Unidata, a division of AIT's designated representative, UCAR.

Activities related to this task for 2014 will include:

1. Add ingest and processing for up to five additional AWOS sites into the AOAWS and test the code in the AOAWS lab environment.
2. Develop, implement and test an AOAWS External Data Services System
  - a. Gather data type requirements for external users
  - b. Evaluate data delivery mechanisms and formats
  - c. Determine compatibility with external user data requirements
  - d. Develop and implement data converters as needed
  - e. Integrate and test the EDSS in the UCAR test environment

- f. Install EDSS on operational systems as part of AOAWS release
  - g. Provide documentation on EDSS components
3. Add ingest and processing on TAMC-generated MET and SPECIAL REPORTS. This includes simulation and testing in the AOAWS lab environment.
  4. Supporting TECRO's designated representative, CAA, in troubleshooting any problems associated with the AOAWS data system on Taiwan.
  5. Support and maintain the existing processing of data types and/or products in the AOAWS including testing and implementing the code changes in the AOAWS test environment.
  6. Update AOAWS Operators manual and convert to PDF format, which is suitable for both printing and on-line browsing. Provide a link to the manuals from suitable AOAWS web pages.

### **Estimated Costs**

<u>Staff</u>	
Software Engineering (23 person-weeks)	US\$ 133,400
<u>Travel</u>	
1 trip @ 1-week	US\$ 12,000
Task #5 Total	US\$ 145,400

### **Task #6: AOAWS System Implementation, Support, and Maintenance**

System administration and software engineering support and maintenance will be provided by AIT's designated representative, UCAR, for the installed AOAWS system and for system upgrades deployed as a part of the AOAWS 13 installation. AOAWS components are located at the Taipei Aeronautical Meteorological Center (TAMC), the Taipei Songshan Airport (RCSS) Weather Station and Flight Information Service (FIS), Taoyuan International Airport (RCTP) Weather Station and FIS, Kaohsiung International Airport Weather Station and FIS, and the Taipei Area Control Center (TACC). AIT's designated representative, UCAR, will continue to subcontract to an experienced Taiwan local technical organization to provide on-site system engineering and information technology support for the AOAWS system components. Defects in the AOAWS system software that arise or develop during this project period (2014) will be addressed and resolved by AIT's designated representative, UCAR.

Support and maintenance services cover software related to AOAWS source code releases made by AIT's designated representative, UCAR. Support and maintenance services for hardware, software or functionality developed outside the released AOAWS source code base, communication network links, and network components used by the AOAWS that are operated by local telecommunication companies and/or TECRO's designated representative, CAA, are not covered under this Implementing Arrangement. However, UCAR will assist TECRO's designated representative, CAA, in troubleshooting hardware and network problems. TECRO's designated representative, CAA, is responsible for running the AOAWS system. AIT's designated representative, UCAR, will respond as appropriate to help ensure that the AOAWS system serviceability level remains consistently high.

This task includes integration and testing in the AOAWS test environment of significant changes made to the operational system, before they are released into the operational AOAWS on Taiwan.

In addition to the support and maintenance work referred to above, AIT's designated representative, UCAR will install the system upgrade (AOAWS Version 13), which will include the functionality of the operational AOAWS plus any new capabilities developed under this Implementing Arrangement. One AOAWS software release and installation will be performed in 2014.

Support and maintenance activities associated with this task in 2014 include:

1. Provide general assistance to TECRO's designated representative, CAA, in supporting and operating the AOAWS including assisting the CAA with any AOAWS related new hardware installation and network configuration changes.
2. Provide assistance to the CAA in troubleshooting problems with AOAWS code, if and when they occur.
3. Support and maintain the installed operational AOAWS Version 12.
4. Integrate operational AOAWS Version 12 changes into developmental AOAWS Version 13 in UCAR lab environment.
5. Create, install, and test AOAWS Version 13 release for the operational system environment.
6. Correct AOAWS defects that arise from the release install.

## Estimated Costs

### Staff

Software Engineering (33 person-weeks)	US\$	191,400
Task #6 Total	US\$	191,400

## Task #7: Conduct Training Program

This task focuses on AOAWS system documentation and training activities that will facilitate the transfer of knowledge to TECRO's designated representative, CAA. AIT's designated representative, UCAR, will continue conducting training programs designed to educate CAA technical staff on the operation and maintenance of the AOAWS system. Training topics will cover the following categories:

- New data sources and data processing
- User display systems (e.g., WMDS, MDS, JMDS, AWOS)
- System operation and monitoring (including SMD display)
- New product development
- System engineering and configuration
- AOAWS External Data Services System

The training will be conducted both at TECRO's designated representative, CAA, facilities on Taiwan, and at AIT's designated representative, UCAR, in Boulder, Colorado, USA. Training materials (e.g., user manuals, PowerPoint presentations, etc.) will also be developed to support the training program.

The training materials will be developed by AIT's designated representative, UCAR, with feedback from TECRO's designated representative, CAA. A Training Plan will be developed for the training program. Activities associated with this task in 2014 include:

1. Prepare a Draft Training Program Plan designed to educate CAA staff on scientific and technical aspects of the AOAWS system.
2. Create training materials designed to educate CAA staff on scientific and technical aspects of the AOAWS system.
3. Conduct training programs designed to educate CAA staff on scientific and technical aspects of the AOAWS system.

### **Estimated Costs**

#### Staff

Software Engineering (7 person-weeks)	US\$	40,600
Scientists (2 person-weeks)	US\$	11,600

#### Travel

1 trip for 2 persons @ 1-week each	US\$	24,000
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Task #7 Total	US\$	76,200
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### **Task 8: SIGWX Chart Editor Replacement**

The SIGWX chart is a critical and required aviation weather product that provides graphical information to the most significant meteorological phenomena for aviation users. Currently, aviation weather forecasters use a chart editor to manually create and draw SIGWX charts based on World Area Forecast Center (WAFC) guidance products. The manual chart creation process can be tedious and time consuming therefore the CAA would like to develop a more efficient process to generate these required charts.

The major objective of this task is to capture user needs from the aviation forecasters and to replace the SIGWX chart editor software with a modern system to provide a more efficient way to generate SIGWX chart products. AIT's designated representative, UCAR, will subcontract to NetSys International (PTY) LTD, the original provider of the SIGWX system to the CAA to collaborate with UCAR to perform the system software replacement. Hardware for the new SIGWX editor system will be purchased by TECRO's designated representative, CAA.

Development and supporting activities associated with this task in 2014 include:

1. Develop list of user requirements for the replacement SIGWX editor software, with the participation of CAA staff.
2. Develop technical specifications for computer hardware and provide to the CAA.
3. Negotiate upgrade content with NetSys International (PTY) LTD.
4. Manage the system procurement and implementation processes.
5. Support the SIGWX system implementation and testing processes.
6. Participate in the SIGWX system site acceptance test at the TAMC.



## Estimated Costs

### Staff

UCAR System Engineering (3 person-weeks)	US\$	17,400
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### Procurement

SIGWX Editor Software <sup>2</sup>	US\$	103,000
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Task #8 Total	US\$	120,400
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## Task #9: Project Management, Administration, and Document Preparation

All technical aspects of the AOAWS-TE project will be managed by AIT's designated representative, UCAR, in cooperation with the project management team from TECRO's designated representative, CAA.

The following sub-tasks will be carried out by the project management team:

1. Carry out general project management, such as planning, budgeting, technical consultations with team members, and tracking progress.
2. Prepare monthly and quarterly progress reports.
3. Obtain and review user feedback on the AOAWS-TE system.
4. Answer technical questions related to the wind shear system acquisition process.
5. Respond to routine technical and information requests from the CAA.
6. Participate in AOAWS-TE related meetings.

## Estimated Costs:

### Staff

General Project Management (15 person-weeks)	US\$	87,000
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### Travel

1 trip @ 1-week	US\$	12,000
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Task #9 Total	US\$	99,000
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## 3.0 Deliverables

IA#17 Quarterly Report #1	15 April 2014
IA#17 Quarterly Report #2	15 July 2014
IA#17 Quarterly Report #3	15 October 2014
IA#17 Quarterly Report #4	4 December 2014
Draft Training Program Plan	15 March 2014

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<sup>2</sup> Cost includes one server license, two client licenses, site testing, and training.

Draft IA#17 Acceptance Plan	15 July 2014
Benefit Assessment Report for CIP, NTDA, and Ceiling and Visibility Products	1 September 2014
AOAWS-TE Version 13 Software Release	4 December 2014
JMDS Version 13 Release (source code)	4 December 2014
WMDS Version 13 Release (source code)	4 December 2014
AWOS Display Version 13 Release (source code)	4 December 2014
AOAWS Manuals and Documentation	4 December 2014
SIGWX Chart Editor Replacement	1 September 2014
Year-End Acceptance Meeting	4 December 2014

#### **4.0 Cost Summary**

Task #1 – Development of In-Flight Icing Diagnosis Product	\$ 58,000
Task #2 – Development and Implementation of the NCAR’s Turbulence Detection Algorithm Product	\$ 104,400
Task #3 – Enhancement of Airport Ceiling and Visibility Prediction Product	\$ 52,200
Task #4 – Display System Enhancements	\$ 99,000
Task #5 – AOAWS Data System Upgrades, Testing, and Integration	\$ 145,400
Task #6 – AOAWS System Implementation, Support, and Maintenance	\$ 191,400
Task #7 – Conduct Training Program	\$ 76,200
Task #8 – SIGWX Chart Editor Replacement	\$ 120,400
Task #9 – Project Management, Administration and Document Preparation	\$ 99,000
Total	US\$ 946,000